

456. Faint.
 464. Very strong broad line. Possibly the 465 line of the bright-line stars.
 468. Moderately strong. Possibly new hydrogen (λ 4686) seen in bright line stars.
 471. Weak. Probably helium (λ 4713).
 The hydrogen lines in the spectra are $H\epsilon$, $H\delta$, $H\gamma$ and $H\beta$.

The lines at λ 370 and 464 are perhaps identical with those observed by von Gothard¹ in the spectrum of Nova Aurigæ, after it had become nebular, but associated with these lines in his record there is the chief nebular line at 5006, no trace of which is yet visible in the spectrum of Nova Persei. On the other hand, $H\beta$, which is the brightest line in the present spectrum of Nova Persei, does not appear at all in von Gothard's spectrum of Nova Aurigæ.

Characteristics of the Hydrogen Lines.—A detailed examination of the lines as photographed on several evenings shows that their structure has been undergoing changes. On February 25 there were three points of maximum luminosity on the F line, the two maxima on the blue side being of equal intensity and greater than the third on the red side. By March 1 the centre one had greatly been reduced in magnitude, and on the 3rd it had been broken up into two portions, thus making four distinct maxima.

Rough measures made on the relative positions of these points of maxima show that the difference of velocity indicated between the two external maxima is nearly 1000 miles per second, while that between the two inner maxima is 200 per second. We thus have indications of possible rotations or spiral movements of two distinct sets of particles travelling with velocities of 500 and 100 miles per second.

A similar examination of the F and G lines of hydrogen in the photographs obtained with the 30-inch reflector has also been made by Dr. Lockyer. In this longer series the most important fact comes out that the change of maximum intensity changes from the more to the less refrangible side of the bright hydrogen line,² and the narrowing of the bright maximum in the middle.

Sofar as the observations have gone they strongly support, in my opinion, the view I put forward in 1877, that new stars are produced by the clash of meteor swarms. I have suggested some further tests of its validity.

We may hope, since observations were made at Harvard and Potsdam very near the epoch of maximum brilliancy, that a subsequent complete discussion of the results obtained will very largely increase our knowledge. The interesting question arises whether we may not regard the changes in spectra as indicating that the very violent intrusion of the denser swarm has been followed by its dissipation, and that its passage has produced movements in the sparser swarm which may eventuate in a subsequent condensation.

THE BEER POISONING EPIDEMIC.

THERE is now a pause in the literature of the most interesting, but at the same time most disastrous, beer poisoning epidemic, and the present seems a fitting opportunity to summarise the chief facts ascertained with regard to it, the deductions to be drawn from them, and, last but not least, the lessons which they teach so far as concerns the prevention of a recurrence of the calamity.

The first fact of transcendental importance was ascertained by Dr. Reynolds, namely, that the beer consumed by these unhappy individuals contained arsenic in such an amount as undoubtedly in many cases to account for the symptoms from which they suffered. So far as subsequent workers are concerned, their results have amply confirmed this fact, and there can be no doubt that the majority of patients in Manchester suffered from what has always been called arsenical poisoning. The next step was directed to ascertain how the arsenic got into the beer. Of this, fortunately, there can be no

doubt it came into the beer from the sugar, and it got into the sugar through the sulphuric acid used either directly or indirectly in the manufacture of the invert sugar or the glucose. It is beside our purpose here to discuss whether all the cases of poisoning were due to the use of sugar made from sulphuric acid supplied either by one firm or prepared from one variety of pyrites. This, although a matter of paramount importance, is not essentially a matter for the man of science to decide. A definite answer to this question can only be obtained by the careful sifting of evidence, the examination of the books of various firms, &c., and is, indeed, a matter for the lawyer rather than for the chemist or pharmacologist. There can be no doubt, however, that the majority of cases observed could be traced to the consumption of beer and stout in the preparation of which sulphuric acid, supplied since the spring by one firm, had been used.

The next actual fact with regard to the causation of the epidemic was, unfortunately, discovered too late to allow of its full significance being thoroughly worked out. Two full months after the consumption of arsenicated beer had ceased, Dr. Tunnicliffe and Dr. Rosenheim demonstrated the presence in relatively large quantities (0.3 per cent.) of selenious acid in the sulphuric acid which was used in the preparation of the invert sugar supplied by the firm implicated in the recent epidemic. These observers subsequently further demonstrated the presence of this substance, which was, indeed, from their earlier work *a priori* almost certain, in the invert sugar itself and also in two different samples of beer identical with that consumed by the poisoned patients in Salford. They also pointed out at the same time that this substance is highly poisonous, certainly as, if not more, poisonous than arsenic, giving rise to symptoms almost identical with this latter poison. Exact quantitative estimations of the amount of selenium in the beer are, so far as we are aware, not yet published, but reckoning from the acid and the sugar we may calculate that this substance was present to the extent of about one quarter the amount of the arsenic present. It follows, then, that the beer consumed in the recent epidemic contained at least two poisonous substances, viz., arsenic and selenium, both of which got into the beer from the sulphuric acid used in the preparation of the sugar.

So far as concerns the actual ætiology of the epidemic, the above are all the facts which we have at present in our possession. Incidentally, however, numerous other points of extreme interest to the physician, the pharmacologist and toxicologist have arisen in the course of the inquiry.

So far as the pharmacology of arsenic is concerned, it is greatly to be regretted that our information concerning the exact amount of arsenic consumed by the individual patients is so inaccurate. This inaccuracy arises from two conditions. Firstly, it has not been in all cases absolutely established that the beer quantitatively examined for arsenic, although coming from the same source as, was identical with that consumed by the respective patients; secondly, the actual amount of beer taken by each patient was in many cases an unknown quantity. The largest amount of arsenious acid found in beer during the epidemic was 1.4 grains per gallon. Some of the sufferers undoubtedly consumed more than a gallon of beer per diem; some, however, did not consume more than a pint. This would mean that, although the former received a highly poisonous dose of arsenic, the latter would do so only in the cases of the very highly arsenicated beers, which were relatively rare. If we assume that arsenic was the only poisonous agent at work, we must also admit that it caused grave poisoning in very minute doses; in some cases, from the published records, these must have been as small as 1/200th of a grain per diem.

¹ *Ast. Phys. Journ.* vol. xii. p. 51, 1897.

² The latest photograph, taken on April 1 shows this peculiarity in a far more pronounced manner, the intensity of the less refrangible component of the hydrogen lines being more than four times that of the more refrangible component.

These profound symptoms of poisoning from such minute doses have given rise to various explanations. The fact that the toxic power of arsenic varies largely according to the chemical form in which it is present, the arseniates, for instance, being barely half as poisonous as the arsenites, has led many to assume that the arsenic was present in the beer either as an arsene, or even in some more subtle biological form. The work of Gossio and others upon the power of the penicillium brevicaulis to form highly poisonous gaseous substances from minute traces of solid arsenic compounds has been adduced by many in support of this hypothesis.

A further consideration of interest in this connection is the fact that arsenic must be considered, at any rate to some extent, a cumulative poison. The interesting and minute work of Gautier upon the excretion of arsenic under normal conditions by the skin, the hair and the menstrual fluid, and the storing of it in the thyroid gland, the thymus gland and the brain, are of especial interest. The recent researches of Sslowow should also find mention here. This observer found that in animals poisoned with arsenic the arsenic was stored in the liver, and further, that it formed a compound with the nucleins, which showed itself to be resistant to the action of hydrochloric acid and pepsin, and that it was, in all probability, stored in this form in the cell nuclei. This work, so far as concerns the storing of arsenic in the liver and its excretion by the epidermal appendages, has been recently confirmed by Dixon Mann.

That arsenic is slowly excreted has been known for some time. E. Ludwig found arsenic in the urine of a dog forty days after the last dose had been ingested, Wood found it in the urine of patients eighty and ninety days after intoxication with arsenic.

Although arsenic may be in this sense cumulative, it does not follow that its poisonous action is cumulative. In fact, its forming an indigestible nuclein compound speaks against this. Further, we know from clinical experience, from the Styrian arsenic eaters, and from numerous pharmacological experiments on animals, that tolerance to arsenic is easily produced. Indeed, continued small doses of arsenic, so far from causing symptoms allied to those which occurred in the beer poisoning epidemic, as a rule improve nutrition and have a general tonic action.

If we pass from the consideration of the nature of the poison to the symptoms which occurred in the Manchester patients, we find many points of extreme interest. Speaking generally, the phenomena present corresponded more or less closely with the classical symptoms of arsenical poisoning. It must be remembered, however, that the discovery of selenium opens the whole question of arsenical poisoning afresh. So far as pharmacological experiments upon animals go, the only difference between the chronic poisonous action of these two substances is that tolerance to selenium is apparently never produced, and that this substance, in continued small doses, produces wasting by virtue of a specific stimulating action which it exerts upon the breaking down of the nitrogenous constituents of the tissues. Thus we must confess that the presence of selenium along with arsenic in the Manchester beer explains many otherwise anomalous symptoms.

It has long been known that excess of alcoholic beverages causes in the drinkers a disease known as peripheral neuritis. The rôle played by alcohol in this disease has heretofore been regarded as sufficiently important to justify the designation of alcoholic neuritis for this condition. It has, however, been observed that the drinkers of certain kinds of alcoholic beverages are much more prone to this affection than the drinkers of others, and further, that the strength of the beverage in alcohol seems to bear no proportion to its proneness to cause so-called alcoholic neuritis. Drinkers of distilled

spirits and wines are much less liable to suffer from peripheral neuritis than beer and stout drinkers. These considerations have led many physicians to look upon this disease as caused by the beverage rather than by the alcohol (C_2H_5OH). Peripheral neuritis was a prominent symptom in the Manchester epidemic, and there can be little doubt it was caused by the arsenic and selenium compounds in the beer. Other metallic and organic poisons, such, for instance, as beri-beri, give rise to a similar condition. This epidemic has, therefore, very much increased the previous doubt concerning the part played by alcohol itself in the so-called alcoholic neuritis.

With regard to the lessons to be learnt from the recent beer-poisoning epidemic, the chief one certainly is to beware of mineral acids in the preparation of all food-stuffs. It is difficult to see how mineral acids, or at any rate acids (in this connection must be observed the difficulty of freeing an acid like tartaric acid from lead) can be dispensed with. They can, however, certainly be put on the market, from whatever source they may be obtained, pure. Although absolute chemical purity must be regarded as a dream of the fatuous ignoramus, there should be no difficulty in the sulphuric acid manufacturers providing an acid which one can term at least harmlessly impure. A further important result of the investigations attending this epidemic is the discovery of selenium in poisonous doses in a beverage actually consumed. This substance has no doubt slipped in and out of many previous arsenic epidemics, escaping observation, as it were, between the stools of chemistry and pharmacology. Now that we are awake to its poisonous existence, in the next arsenic epidemic, which we hope may be long deferred, we shall be able, no doubt, to work out the exact part it plays. It is interesting to note in this connection that it is an impurity of both brimstone and pyrites acid, and that it occurs along with tellurium in certain Japanese sulphurs which are free from arsenic.

MUSICAL ARCS.

WE have already described in a previous issue (NATURE, December 20, 1900, p. 182) the discovery of a new musical instrument in the electric arc made by Mr. Duddell and communicated by him to the Institution of Electrical Engineers last December. The fame, if not the music, of Mr. Duddell's arc penetrated, it appears, to Vienna, where the experiments were repeated at the Technological Institute, and thence returned to the English lay Press. The *Daily Mail* of January 12 last contained an article on "Music in Flame," the result of an interview with Prof. Ayrton on the subject of Mr. Duddell's experiments, in the course of which he suggested that it might be possible to utilise the discovery for the purpose of public entertainment. Would it not be possible, for example, to play a tune upon the arc lamps used in lighting a hall, the musician being at a distance—even outside the building—and playing on the ingenious key-board devised by Mr. Duddell? At the time this article appeared the prophecy may have seemed somewhat extravagant. Mr. Duddell's experiments were conducted, it will be remembered, by shunting an arc burning between solid carbons—the cored carbon arc has no music in its soul—by a circuit containing capacity and self-induction, and the note emitted by the arc was varied by altering the capacity or self-induction in the shunt circuit. The shunt circuit was, however, placed directly across the terminals of the arc, and there was no evidence of any possibility of playing tunes on the arc from any distance; and, further, the arc lamps used in the experiment were hand-fed and it was not unreasonable to suppose that the mechanism and magnet coils of an automatic arc lamp would effectually interfere with the music.